INDUSTRIALES RESEARCH MEETING 16

Neutron detectors of ^{10}B+ZnS(Ag) as an alternative to ^{3}He-based installed in the Radiation Portal Monitors in homeland Security

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Abstract

Using Monte Carlo method features of ^{10}B+ZnS(Ag) neutron detector under real operational conditions has been calculated, this results were compared against measurements. This detector is a viable substitute for 3He detectors installed in custom borders to prevent the illicit traffic of special nuclear materials, SNM.

Introduction

Radiation Portal Monitors, RPM, installed in border areas to fight illicit traffic of Special Nuclear Materials, SNM, have the capability of detecting both gamma rays and neutrons. Usually the employed neutron detectors are pressurized ^{3}He based neutron detectors tubes, but this is being affected by the scarcity in ^{3}He supplies [1]. **The aim of this work is to study the suitability of a scintillator detector of ZnS(Ag) with a mixture of highly enriched of ^{10}B [^{10}B+ZnS(Ag)] as an innovative neutron detectors as replacement to ^{3}He detectors, in order to detect around 2.5 cps- ng of ^{252}Cf, as recommended by the ANSI Standard** [2, 3].

Materials and Methods

Initially, with the MCNPX code, the scintillators´ responses were calculated for different geometries. The response was the amount of ^{10}B(n,α)^{7}Li reactions induced by 29 monoenergetic neutron sources (Fig. 3) [3] and a ^{252}Cf neutron source. Calculations were validated through measurements concluding that ^{10}B+ZnS(Ag) detectors are an alternative for ^{3}He detectors [4]. Proposed detector, were the geometry was optimized, produces around 2.5 cps per ng of ^{252}Cf, being the ideal feature recommended by the ANSI Standard [2]. The ^{10}B+ZnS(Ag) detectors, made by BridgePort Instruments, LLC [5] were tested at the Universidad Politécnica de Madrid (UPM), are rectangular in bars, like the N-48 and N-15 detectors (**Fig. 1**) with 5 sensitive layers (**Fig. 2**). The layers, having ^{10}B, are deposited on plates of PMMA acting as light guide and moderator, surrounded by ~8μm thick aluminum mylar as light reflector. Each detector has a moderator of High Density Polyethylene (HDPE). The complete model of a RPM was the set of PTV gamma detector and the N-48 neutron detector (**Fig. 4**). Using MCNPX code the detection capability of a RPM with the N-48 neutron detector in cps-ng ^{252}Cf was determinate from a ^{252}Cf neutron source and validated through measures.

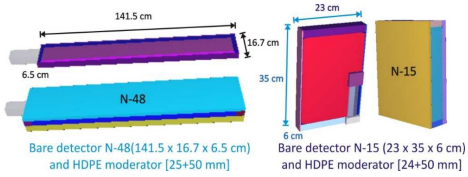


Figure 1. Neutron detectors ^{10}B+ZnS(Ag)

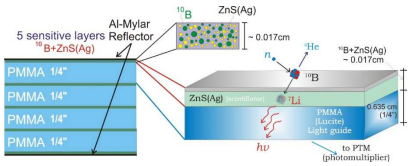


Figure 2. Internal structure of N-48 and N-15 detectors

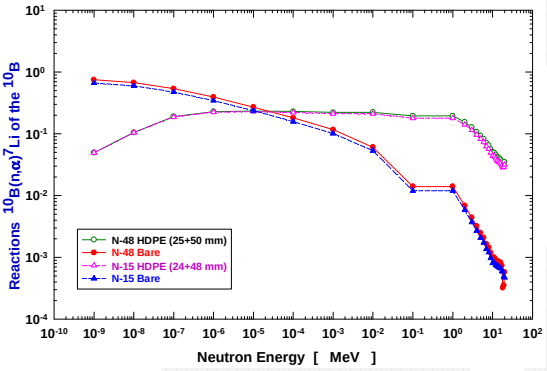
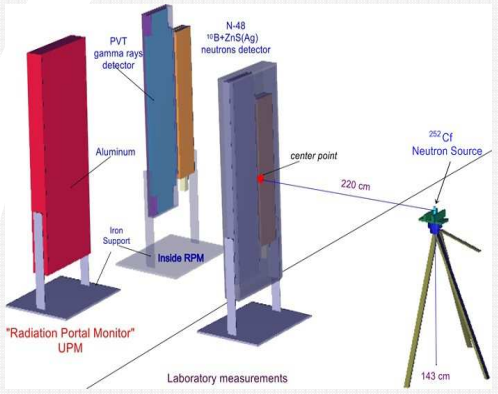


Figure 3. N-15 and N-48 [Bare and with moderator HDPE] Response, ^{10}B(n,a)7Li reactions (per neutron emitted from the sources) [5]



- **RPM MCNPX model to determine the efficiency for a ^{252}Cf in a complete Radiation Portal Monitor N-48 with a PVT detector**

Figure 4. Radiation Portal Monitor, RPM, PVT and N-48

MCNPX Calculations

- Histories in MC large to get ≤3% error.
- Cross sections from the END/B-VI library with S(α, β) treatment [6].

Results

Table 1	Indoors	
Detector	**Measurements [cps-ng^{252}Cf]**	**MCNPX [cps-ng ^{252}Cf]**
N-48 [7]	1.77± 0.10	1.76 ± 0.01
N-15 [5]	0.76 ± 0.20	0.73 ± 0.01
	Outdoor	
N-15 [7]	0.61 ±	0.68 ± 0.02
	RPM in Laboratory (Indoors)	
N-48	1.88 ± 0.20	1.91 ± 0.06

**1ng ^{252}Cf <> 2340 n/s*

Conclusions

The ^{10}B+ZnS(Ag) detectors are an interesting alternative to replace ^{3}He detectors in RPMs. The N-15 detector is considered suitable for portable backpack systems. The N-48 detector is close to be considered a replacement for ^{3}He detectors in RPM. An improvement in the geometry of the detector raising the amount of ^{10}B increases the detector efficiency aiming to reach 2.5 cps/ng ^{252}Cf, defined in the ANSI standards a goal to use this type of detectors as an alternative in RPMs [2].

References

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